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A CERCHAR ABRASIVITY TEST PROGRAM METHODOLOGY DEVELOPED FOR THE SYDNEY COALFIELD, N.S.

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A CERCHAR ABRASIVITY TEST PROGRAM METHODOLOGY DEVELOPED FOR THE SYDNEY COALFIELD, N.S.

by

G.R. Corbett* and T.R.C. Aston**

ABSTRACT

This report outlines the test procedures currently being developed at the Cape Breton Coal Research Laboratory to establish a rock abrasivity index system/data base for use in the Sydney Coalfield, N.S. The establishment of a rock abrasivity index system is considered important since it will allow the performance of rock cutting equipment to be more effectively monitored.

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UNE MÉTHODOLOGIE CERCHAR POUR DES PROGRAMMES D'ESSAI DE L'ABRASIVITÉ MISE AU POINT POUR LE CHAMP HOUILLER DE SYDNEY (N.-É.)

par

G.R. Corbett et T.R.C. Aston

RÉSUMÉ

Le présent rapport est un survol des méthodes d'essai actuellement mises au point au Laboratoire de recherche sur le charbon du Cap-Breton (N.-É.) pour mettre sur pied un système d'indexation/base de données sur l'abrasivité des roches qui sera utilisé dans le champ houiller de Sydney (N.-E.). Ce système d'indexation de l'abrasivité des roches est considéré important parce qu'il permettra de surveiller plus efficacement l'équipement d'excavation.

CONTENTS

	Page
ABSTRACT	i
RESUME	iii
INTRODUCTION	1
EXPERIMENTAL PROCEDURE	1
Step 1 - Calibration of Microscope Eyepiece	1
Step 2 - Initial Preparation and Examination of Styluses	3
Step 3 - Test Procedure	7
Step 4 - Final Examination	7
REPORTING OF RESULTS	13
DISCUSSION	13
REFERENCES	14

TABLES

No.		
1.	Equipment list	3
2.	Reporting of results	12

FIGURES

1.	Abrasivity stylus	2
2.	Stylus mount	4
3.	Microphotographic equipment and photographs produced	5
4.	Stylus tip examples (new styluses)	6
5.	Stylus tip examples (used styluses)	8
6.	Stylus tip examples (unusable styluses)	9
7.	Bench top holder and balsa shipping carton developed by CBCRL	10
8.	CERCHAR abrasivity machine	11

INTRODUCTION

Rock cuttability can be predicted by means of a laboratory test developed by CERCHAR of France (1). CERCHAR hardness and abrasivity testing is undertaken on samples of the stone to be bored or cut. Using these two test procedures, the performance of the rock cutting equipment can be predicted (2).

The CERCHAR hardness test provides a measurement of rock hardness by measuring the penetration rate into a rock sample by a carbide drill bit under constant load and rpm. The measured penetration rate is equated to a CERCHAR hardness index (CHI), which in turn can be converted into a compressive strength for the rock sample.

The CERCHAR abrasivity test provides a description of the rock sample according to the tool wear produced. The abrasivity stylus, Figure 1, is dragged across the sample for an exact distance under a constant load. The wear produced on the stylus tip is measured as a diameter and the measurement converted to a CERCHAR abrasivity index (CAI).

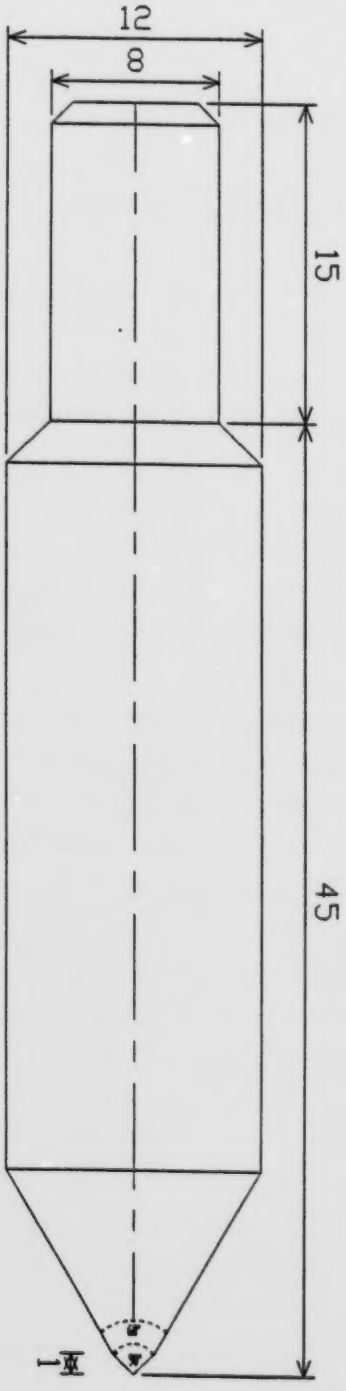
In 1987, a multi-year research program was established by the Cape Breton Coal Research Laboratory (CBCRL) to investigate rock cuttability and machine performance in the Sydney Coalfield, N.S. (3). The initial objectives of this program are to compile a rock abrasivity/hardness data base and index system, developed from the laboratory testing of field samples. This report examines the procedures being developed at CBCRL for the abrasivity testing program with respect to test methodology and data reporting. Similar details regarding the hardness testing program will be submitted in a later report.

EXPERIMENTAL PROCEDURE

Table 1 lists the equipment used in the abrasivity program. In determining the CERCHAR abrasivity index for a sample of rock, four main steps should be followed:

STEP 1 - CALIBRATION OF MICROSCOPE EYEPIECE

The microscope eyepiece should be calibrated using the measuring graticle so that the exact dimensions of the eyepiece micrometer can be



SPECIFICATIONS

STEEL;
TYPE 100-C6, SAE-01
ROCKWELL HARDNESS 54 - 56
200 - 215 Kg/mm²

ANGLE TOLERANCE ±.25°
SHARPENED TO "DEAD SHARP"

DIMENSIONS IN MILLIMETERS

Figure 1 - Abrasivity stylus

determined at the magnification (~40x) being used. This allows the exact dimensions of the stylus wear diameter to be determined by the operator, by comparing the eyepiece micrometer to the test sample and multiplying by the calibration factor to give the exact measurement in millimeters.

Table 1 - Equipment list

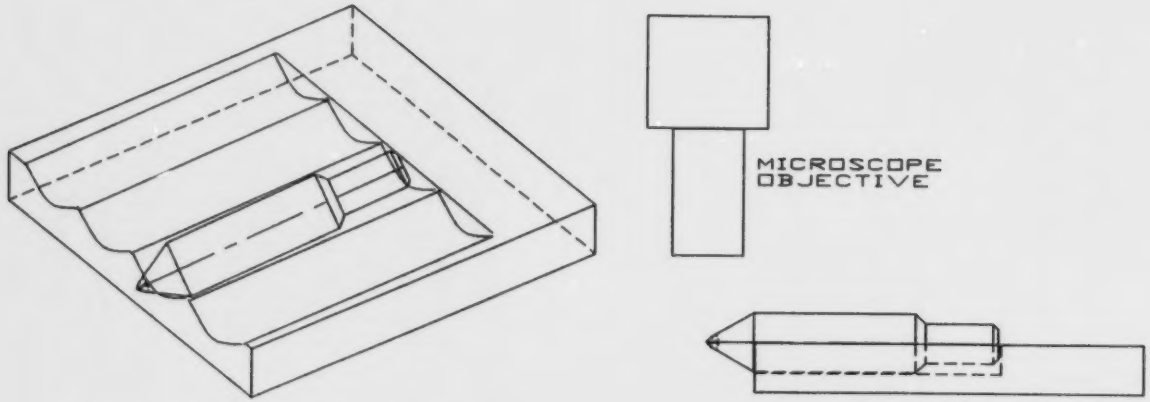
1) CERCHAR Abrasivity Machine
2) Abrasivity Styluses
3) ZEISS Universal Binocular Microscope
   - equipped with photographic capabilities
4) Wild M3B Binocular Microscope
5) Measuring Micrometer for calibration of microscope
6) Stylus Holder (developed by CBCRL)
7) Stylus Mount (developed by CBCRL for use with microscope)
8) Stylus Transportation Case (developed by CBCRL)
9) Dremel Electric Engraver

STEP 2 - INITIAL PREPARATION AND EXAMINATION OF STYLUSES

All test styluses should be logged and engraved with a reference number prior to use. Each stylus should be examined under the binocular microscope at a magnification which allows the operator good tip definition. In the inital phase, this value was determined to be approximately 40x. The stylus mount (Figure 2) developed by CBCRL makes it possible to mount several styluses at once and allows the operator better handling and ease of measurement.

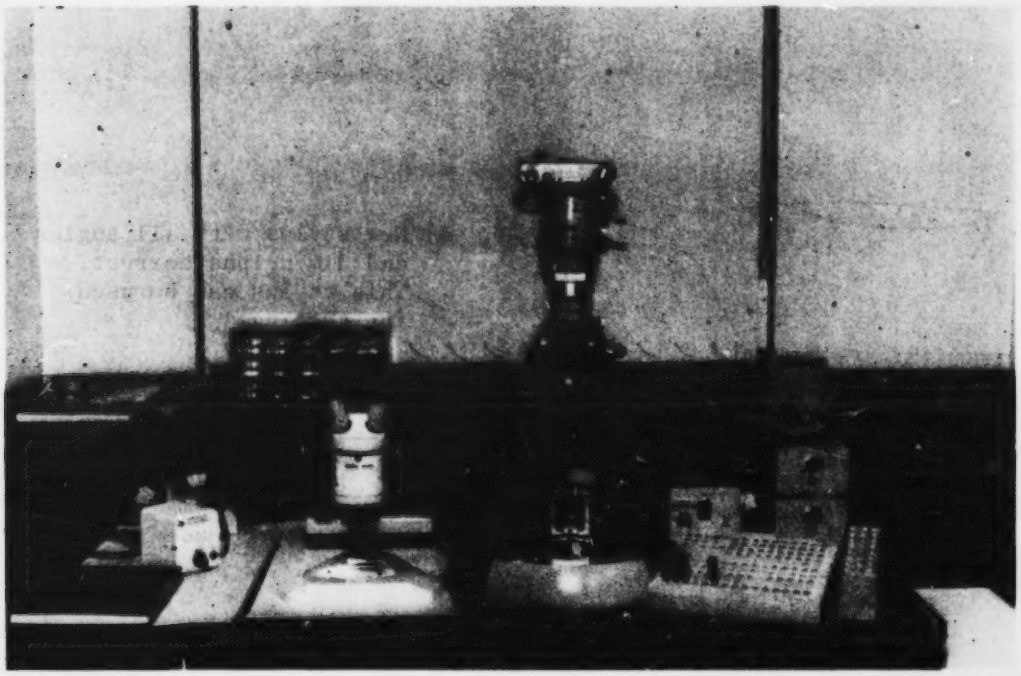
Photographs of the styluses may be taken if the microscope is so equipped and these can aid in the measurement and interpretation of the results. Figure 1 shows the dimensions of the stylus and gives the specifications. Figure 3 shows the microscopes used at CBCRL and photographs of the stylus tips along with comments.

Theoretically the stylus tips should be sharpened to an exact point before use, Figure 4a. However, in practice the stylus tips have been



STYLUS MOUNT FOR USE WITH MICROSCOPE

Figure 2 - Stylus mount

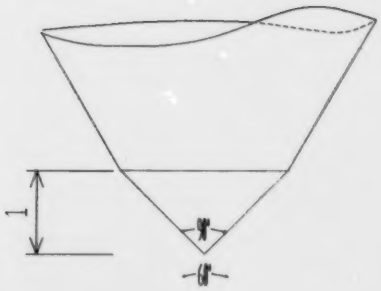


a) microscopes used for measurement and photography

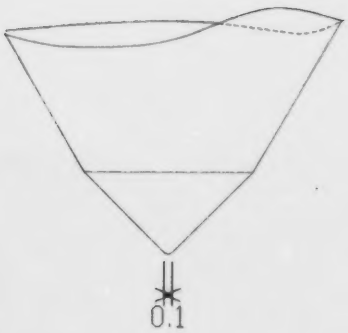
b) Sharp Abrasivity Stylus - Reading less than 0.1 mm diameter equal to CAI of less than 1.

c) Damaged Abrasivity Stylus - Reading CAI approximately 3.

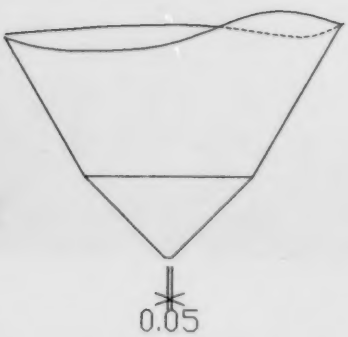
Figure 3 - Microphotographic equipment and photographs produced



a) New stylus with all angles and dimensions correct. This stylus can be used for testing.



b) New stylus with a measurement of 0.1 mm representing a CAI of 1.0. This stylus cannot be used for a test and must resharpened.



c) New stylus with a measurement of 0.05 mm (CAI = 0.5). This value is a critical value, the stylus can be used for testing.

Figure 4 - Stylus tip examples (new styluses)

measured with slight readings before use (Figures 4b and 4c), for example 0.06 mm represents a CAI of 0.6:

$$CAI = 10 \times \text{stylus wear diameter} \qquad \text{Eq. 1}$$

It was therefore decided to adopt a critical value of 0.05 mm for the lower limit of acceptable stylus damage. A stylus with a pretest measurement of 0.05 mm or greater would not be used in a test but would be resharpened. Any stylus with a 0.05 mm or less diameter value before sharpening constitutes a good pin and therefore measurements could continue, Figures 4,5,6.

The pretest examination of the abrasivity styluses is necessary to verify the zero measurement of the stylus before testing, since experience has shown that because of the well defined tip specifications and steel strength, damage can occur very easily, for example during shipping, Figure 6b. A bench top stylus holder and shipping cartons have been developed by CBCRL to facilitate damage free transportation and handling, Figure 7.

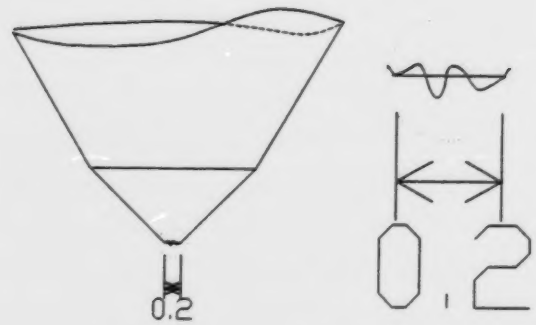
STEP 3 - TEST PROCEDURE

All styluses having acceptable diameters as determined in Step 2 are then used with the CERCHAR abrasivity index machine. For the testing procedure, the rock samples need little preparation and can be either core samples or irregular lumps. However, the actual test location on the samples should be as flat as possible to ensure a more reliable test, Figure 8.

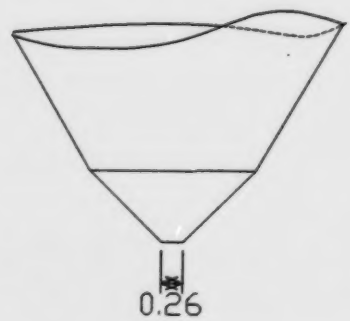
The sample should be approximately 5-10 cm in length and carefully viced into the apparatus. The test stylus is locked into the chuck. The stylus tip is then carefully placed on the test sample and dragged for an exact distance of 10 mm in one second under a constant load of 7 kg. Several tests are run per sample in order to obtain a valid number for each sample type.

STEP 4 - FINAL EXAMINATION

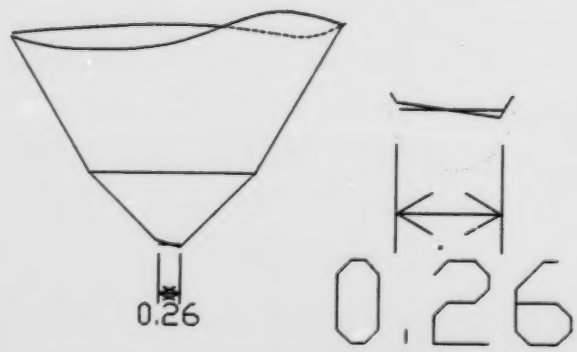
Upon completion of Step 3, all the styluses are re-examined and measured under the microscope at the predetermined magnification, preferably by the same operator, since measurement of these wear diameters can be very



a) Used stylus after a scratch test has been performed. Average value represented by the straight line is the measured wear diameter (0.2 mm = 2.0 CAI).

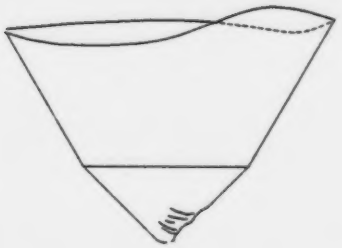


b) Used stylus perfectly worn. The wear diameter measurement = 0.26 mm representing a CAI of 2.6.

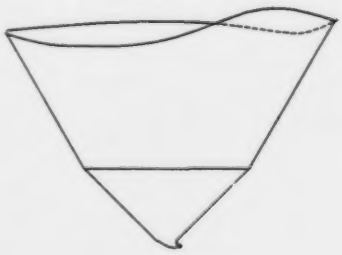


c) Used stylus after a scratch test has been performed. Average value represented by the straight line is the measured wear diameter (0.26 mm = CAI of 2.6)

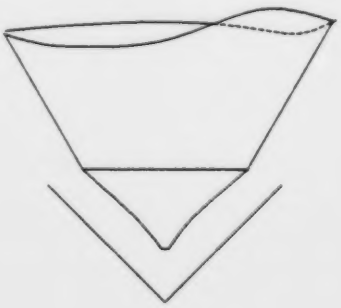
Figure 5 - Stylus tip examples (used styluses)



a) Unusable stylus after a scratch test has been performed. The test was not successful because the sides of the pin have worn. Therefore a measurement cannot be taken.

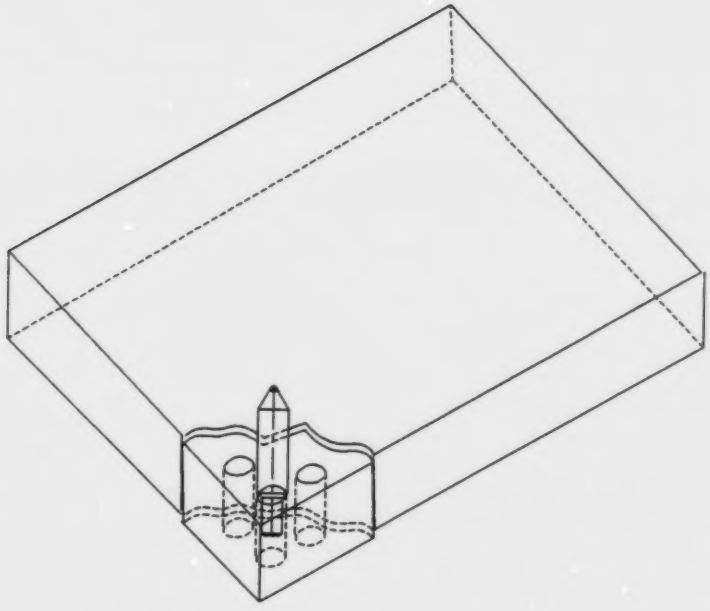


b) Stylus was dropped or damaged due to shipping or handling. The stylus is unusable and must be resharpened.

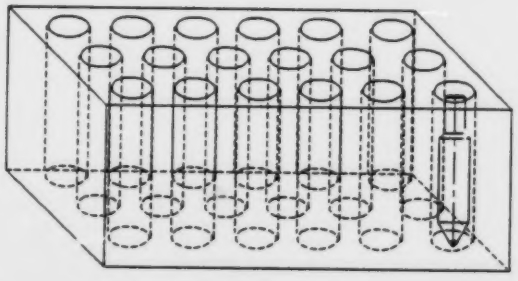


c) Unusable stylus because it was not prepared properly. Critical angles are wrong. The stylus must be resharpened.

Figure 6 - Stylus tip examples (unusable styluses)

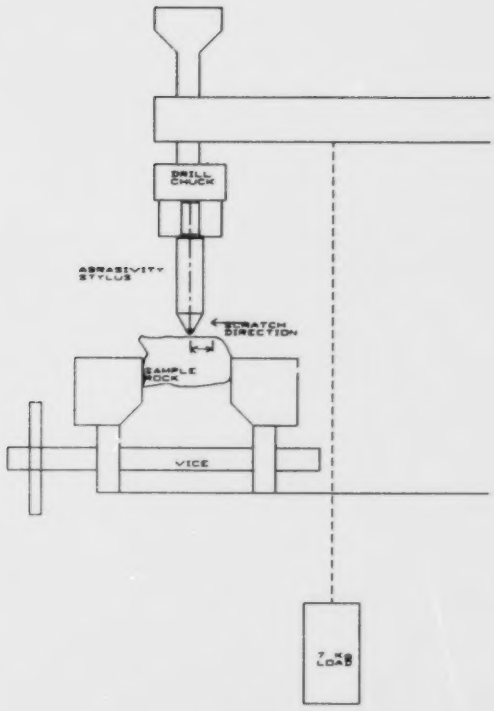


BENCH TOP HOLDER



BALSA SHIPPING CARTON

Figure 7 - Bench top holder and balsa shipping carton developed by CBCRL



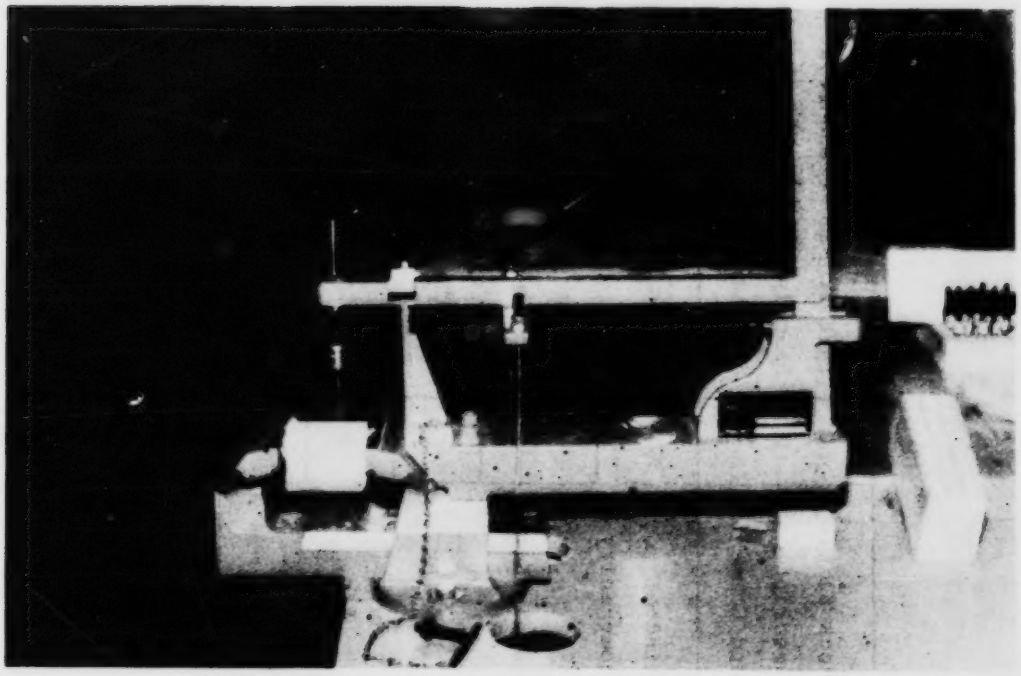


Figure 8 - CERCHAR abrasivity machine

Table 2 - Reporting of results

Rock Sample #	Rock Sample Description and Comments	Pin # i	Initial Pin Description and Comments	Pin Point Initial Diameter	Final Pin Description and Comments	Final Pin Diameter	Average Pin Diameter For Sample	CAI for Sample
1	Kind of rock homogenity Grain Size Bedding Etc.	1 2 3 4 5	The appearance of the stylus (Step 1) will be described, its initial diameter and acceptability.	X_i	Description of appearance of stylus (from Step 3) after it has been run in the test and the diameter of the point of the pin.	Y_i	$Z_i = Y_i - X_i$ For a certain rock sample, the stylus point diameter is calculated.	$A_i = Z_i \times 10$ For the stylus diameter, the CAI is calculated for each rock sample.
							$\bar{Z}_i$	$\bar{A}_i$

$\bar{Z}_i$ - the average CAI is calculated based on 'i' styluses

$\bar{A}_i$ - the average stylus wear character is calculated for 'i' styluses

subjective. The available photographs and drawings (Figures 3,4,5,6) aid in this regard.

A measured scratch diameter of 0.1 represents a CAI of 1.0 and each increase in diameter of 0.1 equals an increase in CAI of 1.0, Equation 1.

REPORTING OF RESULTS

Table 2 is suggested for the reporting of the test results. Care should be taken to try and include as many factors as possible which can influence the abrasivity measurements: sample lamination, scratch direction (paralled or perpendicular or at an angle to the bedding), etc. It is essential that all possible factors which may contribute to the abrasivity results be identified and evaluated.

DISCUSSION

The CERCHAR abrasivity index is currently being used in France by companies concerned with the problems of rock excavation. It could therefore be used to enhance production rates in the Sydney Coalfield by predicting machine tool wear prior to cutting. However, this requires the establishment of an extensive abrasivity data base. It is thought that the grain size plays a dominant role in the abrasivity of the sample. It is therefore envisioned that a testing program should be undertaken on several standard rock samples from within the Sydney Coalfield which range from very fine grained, mudstone or shale to a very course grain sandstone. Other factors such as silica or cement content should also be considered. An abrasivity index could be determined for approximately 30 types of strata in the Sydney Coalfield thereby allowing easy identification of samples at the work location and allowing machine parameters to be changed more rapidly to meet the cutting conditions and thereby increasing production.

This report represents the initial phase of abrasivity testing for samples from the Sydney Coalfield. The procedures listed are an overview and may be adjusted as testing continues. It is essential that the quality of the styluses be continually monitored because of their vulnerability to damage by

handling and shipping. In addition, several small scale tests will be planned to verify the steel integrity after resharpening, and the optimum number of tests available from a stylus.

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